WY CSF 5.4.4.3
WY CAR 2.4.4

SEDIMENT FEASIBILITY STUDY ALTERNATIVE DEVELOPMENT TECHNICAL MEMORANDUM 2 PACIFIC SOUND RESOURCES MARINE SEDIMENTS UNIT SEATTLE, WASHINGTON

Prepared for

U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

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98-0221.doc

ARCS QUALITY ASSURANCE CONCURRENCE

Sediment Feasibility Study
Alternative Development
Technical Memorandum 2

Project Name:	Pacific Sound Resources Marine Sediments Unit Seattle, Washington
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MARINE SEDIMENTS UNIT FEASIBILITY STUDY
ALTERNATIVE DEVELOPMENT
TECHNICAL MEMORANDUM 2

1. INTRODUCTION

As part of the Feasibility Study (FS) for the Marine Sediments Unit of the Pacific Sound Resources (PSR) Superfund site, Roy F. Weston, Inc. (WESTON®) will, prior to publication of the FS report, prepare three technical memoranda to develop key components of the cleanup options for the site. EPA is taking an serial approach to the feasibility study because a number of unique constraints or issues have been identified that will affect cleanup options for the site (see Section 4 for discussion). These memoranda will be used to solicit input and develop a consensus internally within the U.S. Environmental Protection Agency (EPA) and with other reviewing agencies regarding the most acceptable approach to remediating the Marine Sediments Unit (MSU).

This memorandum is the second of the three memoranda. The purpose of this memorandum is to develop and present a set of potential alternatives that will undergo detailed evaluation in the FS. These alternatives are currently viewed by EPA as a reasonable set of options to evaluate further. However, it is anticipated that reviewer's comments will provide refinements to these alternatives; EPA will also consider any additional reasonable alternatives that are identified by reviewers.

Identification and screening of technologies was completed in Technical Memorandum 1 (WESTON 1998a). That memorandum identified several preliminary technologies and screened them to determine which should be further developed into alternatives in the FS and which should be eliminated due to technical or financial constraints. Based on the initial screening, the following technologies were retained and used to develop remedial alternatives:

- Capping
- Removal
- Disposal

2. DEVELOPMENT OF FEASIBILITY STUDY ALTERNATIVES

2.1 Development of Alternatives

These technologies were applied either individually or in combination in several alternatives designed to achieve sediment quality that is protective of human health and the environment as defined by the Washington State Sediment Management Standards (SMS). As reported in the

MSU RI, polycyclic aromatic hydrocarbons are the primary contaminants of concern for the MSU. The areas with surface sediment exceeding Sediment Quality Standards (SQS) or Cleanup Screening Levels (CSLs) for PAHs is depicted in **Figure 1**. The SQS exceedance area represents an area of about 94 acres and 967,000 cubic yards of contaminated material; within that area, 47 acres (471,000 cubic yards) also exceed CSLs. A No Action response was included in the development of the alternatives to provide a benchmark against which all other alternatives will be compared in the detailed evaluation.

For the purposes of this memorandum, it was assumed that dredging at depths below -200 feet mean lower low water (MLLW) was not practicable due to equipment limitations and costs. Dredges available in Puget Sound are typically not equipped to dredge much deeper than -90 feet, since most of the dredging is for navigational purposes. However, some local dredging companies can cost-effectively modify their equipment to attain depths closer to -200 feet using clamshell buckets. Dredges in the Great Lakes region and elsewhere in the United States that have depth capabilities greater than that typically used in Puget Sound could also be mobilized for use at the PSR MSU. Dredging capabilities affected the development of alternatives because surface sediments with concentrations of PAHs above their respective CSLs occur at depths greater than 200 feet.

This memorandum focuses on the potential alternatives, cleanup areas, cleanup levels, and the quantities of contaminated sediment to be removed rather than on other specific features of each alternative (such as dredge type, monitoring frequency, etc.). These components will be discussed with more specificity in the detailed evaluation of alternatives (Technical Memorandum 3) after the generalized alternatives in this memorandum are finalized following agency review.

A common component that will be considered in each detailed alternative will consist of evaluating what engineering features could be employed to ensure groundwater flowing into the bay does not exceed ambient water quality criteria or impact sediment quality. An evaluation has been completed as part of the Upland Unit and MSU remedial investigation that suggests contaminants (particularly selected low molecular weight PAHs) transported in groundwater from some areas of the site have the potential to exceed ambient water quality criteria upon discharge to Elliott Bay and impact sediment quality over time. Therefore, each detailed alternative design may include such items as placing clean fill to extend the shoreline (and adsorb contamination) and increasing the cap thickness to ensure cap maintenance is required infrequently.

2.2 Sediment Alternatives

The proposed alternatives to be evaluated in detail in the FS are described below:

2.2.1 Alternative 1—No Action

This alternative consists of no removal or isolation of the contaminants in sediments. No engineering or administrative controls are implemented to prevent human exposure. Ecological impacts and risks association with no action are detailed in Appendix K of the MSU RI (WESTON 1998b). A No Action response will not meet the remedial action objectives for the site but is provided for comparison purposes to gauge the effectiveness of other alternatives.

2.2.2 Alternative 2—Dredging to CSLs

This alternative consists of dredging sediment that exceeds cleanup screening levels (CSLs) for contaminants of concern (PAHs) in the MSU and disposing of the sediment in a nearshore disposal site or a confined aquatic disposal site. All sediment at depths less than -200 feet MLLW (the assumed practical limits for dredging) that exceed these criteria would be dredged and placed into an appropriate disposal site. Sediment exceeding CSLs deeper than 200 feet (about 7 acres) would not be remediated. All sediment would be removed until CSLs were achieved at the exposed sediment surface. In dredged areas, the remaining sediments would be characterized by PAH concentrations less than or equal to the CSL. This alternative would require dredging 423,000 cubic yards of sediment. The proposed dredging area (40 acres) for this alternative is provided in **Figure 2**. Removal would need to be accomplished with a dredge that resulted in a minimum of suspended solids since the contaminated sediment in many locations contain exceedingly high concentrations of PAHs. There are hydraulic dredges that can remove sediments with up to 60 percent solids with little to no turbidity in comparison to conventional dredges that entrain surface water resulting in a slurry of only 10 percent solids. The dredged sediment would be disposed in either a nearshore or aquatic disposal site.

2.2.3 Alternative 3—Capping

Alternative 3 presents two different capping configurations to achieve different potential cleanup levels.

2.2.3.1 Alternative 3a—Capping to SQS

This alternative consists of capping all sediment that exceeds SQS-based cleanup goals with three feet of clean sand. The capping material would be obtained from maintenance dredging projects in the Puget Sound area and would be characterized by PAH concentrations less than the SQS.

The majority of the sediment that exceeds SQS criteria in the MSU is located at a depth of less than -240 feet MLLW. Capping at this depth is approaching the practical limits for accurately and efficiently placing cap material but is still considered feasible.

This alternative would consist of capping 455,000 square yards (94 acres) of the project area as shown in **Figure 3**. About 525,000 cubic yards of cap material would be needed to provide approximately 15 percent additional material to account for loss during placement.

Institutional controls to prevent anchoring large ships in the area where the cap was constructed would be implemented as part of this option.

2.2.3.2 Alternative 3b—Capping to CSLs

This alternative is similar to Alternative 3a, except that the area to be capped is determined based on exceedances of CSL in surface sediment. This alternative consists of capping all sediment that exceeds CSL criteria (see **Figure 4**) with three feet of clean sand. As with all capping options, the capped areas will be cleaner than the SQS for PAHs.

The majority of the sediment that exceeds CSLs is located at depths of less than -200 feet MLLW. Material in this depth range can be accurately and efficiently placed using several techniques including bottom dumping from a barge or hydraulic washing.

This alternative would consist of capping 227,000 square yards (47 acres) of impacted sediment. Approximately 260,000 cubic yards of clean cap material would be needed to provide an additional 15 percent of capping material to account for loss during placement.

Institutional controls to prevent anchoring large ships in the area where the cap was constructed would be implemented as part of this option.

2.2.4 Alternative 4—Fill Area Removal

Alternative 4 presents two different configurations that potentially provide optimal removal of contaminant mass, while reducing the cleanup costs. As part of the detailed evaluation of alternatives, different combinations of dredging and capping may be considered in order to determine the most cost-effective approach, considering all the site-specific constraints (see Section 4).

2.2.4.1 Alternative 4a—Fill Area Removal to SQS and Capping

This alternative consists of removing sediment containing contaminants in excess of SQS from the area predicted by the USGS sub-bottom profiling data (see Section 2.1.6.5 of the RI for additional information) to be non-native (potential fill) material. The fill area is defined as the area where contaminated material has accumulated to a thickness greater than three feet. As shown by the fill contours in **Figure 1**, there are several areas where mounds of contaminated fill may have been placed. Depth of this material in many areas is approximately 12 to 15 feet. The fill area generally extends outward 700 feet from the main dock (see **Figure 1**). The fill elevation contours correlate well with the depth of contamination that exceeds both SQS and CSL cleanup criteria based on evaluation of shallow core results. This accurate correlation indicates the fill area is relatively well defined and contains the majority of the contaminants.

A contaminant mass/volume calculation was completed to determine what percentage of the total contaminant mass was contained in fill area. This evaluation showed that by removing this fill material, 96 percent of the mass of contaminants above SQS was removed while removing only 47 percent of the total volume of contaminated sediment above SQS standards. A summary of the evaluation is provided in **Table 1**.

Table 1—Comparison of Fill Area Contamination vs. Total Site Contamination

Cleanup Criteria	Total Mass (lbs)	Total Volume (CY)	Total Area (sq. ft.)	Fill Area Mass (lbs)	Fill Area Volume (CY)	Fill Area (sq. ft.)
SQS Criteria	1,167,000	967,000	4,100,000	1,130,000	450,000	1,130,000

This alternative removes contaminated fill material such that the sediment remaining in the dredged area after removal meets SQS criteria. SQS would be achieved in the surrounding areas by capping with three feet of clean sand. Removal and capping areas are shown in **Figure 5**.

In this alternative, approximately 450,000 cubic yards of sediment would be dredged within the 26 acre fill area. The remaining 68 acres that exceed SQS criteria outside of the fill area would require approximately 380,000 cubic yards of clean sediment to construct the cap (this volume includes an additional 15 percent to account for loss during placement). Areas that were dredged to meet SQS standards would not need to be capped to meet remedial action goals.

Institutional controls to prevent anchoring large ships in the area where the cap was constructed would be implemented as necessary.

2.2.4.2 Alternative 4b—Fill Area Removal to CSL and Capping

This alternative is similar to Alternative 4a except the fill area would be dredged until CSL levels were met at the exposed sediment surface. Remaining areas exceeding the CSLs outside of the dredged area, would be capped with three feet of clean sand. Capping would not be performed in areas where dredging to CSLs occurred. Dredging and capping areas are shown in **Figure 6**.

A contaminant mass/volume evaluation was completed to determine what percentage of the total CSL contaminant mass was contained in the source area. This evaluation showed that by removing this fill material, 98 percent of the mass of contaminants above CSL standards is removed while removing 70 percent of the total volume of contaminated sediment above CSL standards. A summary of the evaluation is provided in **Table 2.**

Table 2—Comparison of Source Area Contamination vs. Total Site Contamination

Cleanup Criteria	Total Mass (lbs)	Total Volume (CY)	Total Area (sq. ft.)	Fill Area Mass (lbs)	Fill Area Volume (CY)	Fill Area (sq. ft.)
CSL Criteria	920,000	471,000	2,050,000	903,000	326,000	1,130,000

In this alternative, approximately 326,000 cubic yards of sediment would be dredged within the 26-acre fill area.. The remaining areas (approximately 21 acres) that exceed CSLs would require about 117,000 cubic yards of clean material (including a 15 percent placement loss) to construct a 3-foot cap.

Institutional controls to prevent anchoring large ships in the area where the cap was constructed would be implemented as necessary.

2.3 Summary of Alternatives

Table 3 provides a summary of the key components of each of the alternatives and the basis on which they were developed.

3. DISPOSAL AREAS

Currently, limited sites are available for disposal. The closest upland sites that may be considered are located in Tukwila and the Green River Valley (Cagney, P. Pers. Com). Confined aquatic disposal sites of adequate size and depth in Elliott Bay are also limited (Parametrix 1994). The most reasonable disposal option at this point in the FS appears to be nearshore disposal adjacent to (east of) the PSR facility and is thus the focus of the following presentation. Other nearshore disposal areas may be identified based on agency review comments; reasonable sites will be included in the detailed evaluation memorandum. Confined aquatic disposal sites may also be included in the detailed analysis of the alternatives, following further discussions with EPA, the U.S. Army Corps of Engineers, Washington Department of Natural Resources, and others.

3.1.1 Nearshore Disposal

The nearshore area east of the PSR pier extending over onto the Lockheed site has a relatively low sloping bottom with depths ranging from -5 feet MLLW to -35 feet MLLW with the majority of the area being at least -25 feet MLLW. Preliminary estimates indicate this site may have the capacity to hold up to 1 million cubic yards of sediment.

Nearshore disposal could be accomplished by constructing a berm running eastward from the PSR main pier to one of the Lockheed piers. Several different configurations were considered in order to achieve different capacities based on in-place volumes of contaminated sediments. Actual volumes to be disposed of will be affected by bulking that occurs during removal and disposal. The degree of increase in volume can range from 10 to 30 percent and is dependent on the dredging and sediment transport (pipe versus barge) selected as part of an alternative.

Table 3—Alternative Summary

Alternative	Dredging Volume (cubic yards)	Capping Area (square yards)	Cap Material Volume (cubic yards)	Rationale
Alternative 1: No Action	0	0	0	Required as a baseline for which to compare other alternatives
Alternative 2: Dredging to CSLs	423,000	0	0	Removes 85% sediment in excess of cleanup levels, is protective and has good long-term effectiveness
Alternative 3: Capping *3a: Cap SQS exceedance areas* *3b: Cap CSL exceedance areas*	 NA NA	 455,000 227,000	 525,000 260,000	Minimizes cost and is protective overall. Capping in area of groundwater transport may require long-term maintenance.
Alternative 4: Contaminated Fill Area Dredging and Capping *4a: Removal/cap to SQS* *4b: Removal/cap to CSLs*	 458,000 326,000	 330,000 102,000	 380,000 117,000	Dredging the contaminated fill removes greater than 95% of the total mass of contaminants present above cleanup levels. Capping the lower concentration lessor contaminated areas protects human health and the environment from the remaining contaminants left in place.

To dispose of material removed as part of Alternative 2 (Dredging to CSLs), Configuration A depicted in **Figures 7 and 8** could be constructed. This berm configuration provides a disposal capacity of approximately 425,000 cubic yards. The approximate length of the berm would be 1,700 feet. The berm would be constructed to an elevation of approximately 15 feet above MLLW such that the top edge was equivalent in height to the upland area. The bottom of the berm would range in depth from approximately -6 feet to -45 feet MLLW. The berm foot print would rest on relatively flat sediment except for the area near the PSR main pier where the bottom drops in depth over a relatively short distance. The width of the berms foot print will vary based on depth and is estimated to be a maximum of 160 feet wide (approximately) at its deepest point.

Berm construction could consist of riprap with sand infill to act as a barrier to sediment migration through any gaps in the riprap. Because of the high concentrations of contaminants in the sediment, it is assumed that hydraulic dredging will be used to minimize solids resuspension. The berm would be constructed with a notch in the top that would be used to relieve dredge water from inside the disposal area. To ensure no contaminants escaped with this water, an oil boom and/or activated carbon would be used to capture any oil that may exist on the surface water.

The area enclosed within the berm would be filled with contaminated sediment to an elevation of approximately +10 feet above MLLW to ensure the sediment remains saturated. The remaining 3 to 5 feet would be filled with clean material to serve as a construction surface.

The hydraulically-dredged solids would be pumped via floating pipeline to the south side of the disposal site such that any suspended solids created upon discharge would be given adequate settling time to improve the quality of the water that is released back into Elliott Bay. The areas of highest PAH concentrations would be dredged first such that this material could be placed at the back of the disposal site.

Removal of the sediment in Alternative 4a could be accomplished with a dredge similar to Alternative 2. The dredged material would be pumped into the nearshore disposal site. The areas of highest contamination would be dredged first such that this material could be placed at the back of the disposal site allowing the suspended solids more time to settle. Areas of lower contamination would be dredged last.

A potential nearshore disposal site that could be used to dispose of dredged sediment generated as part of Alternative 4a is shown in **Figure 9**. This location would require constructing a berm similar to Alternative 2 running from the PSR main pier eastward. The berm would be approximately 1,900 feet long and be constructed of rip-rap and sand. The base of the berm would vary in depth from -6 to -35 feet MLLW and be a maximum of 160 feet wide.

Dredging and disposal conducted as part of Alternative 4b would occur similar to that discussed in Alternative 4a. In this alternative the nearshore disposal site would be similar to that shown in

Alternative 2 except it would only extend as far as the second pier as shown in **Figure 10**. This disposal configuration would require construction of a berm 1,500 feet long.

4. SITE-SPECIFIC CONSTRAINTS AFFECTING REMEDIAL ALTERNATIVES

Development and design of remedial alternatives for the contaminated sediment within the PSR MSU must account for a number of site-specific conditions or issues that may affect cleanup decisions. These constraints include the following:

- Physical configuration of the site—The PSR MSU is a large area with the majority of the contamination occurring in water deeper than 30 feet. Concentrations of PAHs exceed the SMS at depths greater than 200 feet. Highly contaminated portions of the site are also steeply sloped.

- Potential use of the Lockheed area for a multi-user disposal site—A draft cleanup action plan indicates that this area will be used as a multi-user nearshore disposal site. Construction of a nearshore facility for disposal of PSR MSU material will need to be coordinated with any uses of the Lockheed offshore site.

- Maintenance of navigation and commerce—The development of alternatives for the western portion of the MSU cannot interfere with the navigational needs of Crowley Marine at Pier 2.

- Shoreline public access—Construction of a nearshore disposal facility will be contiguous with the public access and viewing areas that is being constructed by the Port of Seattle. Design of the nearshore facility will need to address recreational use/public access.

- Availability of capping material—Capping will require the availability of a large quantity of clean sediment. Currently, the timing and quantity of available material is unknown.

- PSDDA disposal—Some areas of the site with SMS exceedances but minimal accumulation may be able to be disposed of at the PSDDA site in Elliott Bay. Use of this site would require coordination with the Dredge Materials Management Program and additional surface and subsurface testing in the areas that may apply.

5. INFORMATION NEEDS

The following information is needed to complete the development and evaluation of the sediment remedial alternatives:

- Disposal site availability and capacity—An inventory of nearshore and confined aquatic disposal sites is being performed by the U.S. Army Corps of Engineers and will be available during review. This information will be used to complete the evaluation of potential disposal sites.

- Sediment resuspension potential based on dredge types—Information from dredging work performed in Commencement Bay and other aquatic sites in the United States will be obtained, to the extent available, to help evaluate the most optimum type of dredge to employ at PSR.

6. REFERENCES

WESTON (Roy F Weston, Inc.). 1998a. Pacific Sound Resources, Sediment Feasibility Study, Alternative Identification and Screening (Technical Memorandum 1). Prepared for U.S. Environmental Protection Agency, Region X, Seattle, WA. Roy F. Weston, Inc., Seattle, WA. 29 January.

WESTON (Roy F Weston, Inc.). 1998b. Pacific Sound Resources, Marine Sediment Unit Remedial Investigation. Prepared for U.S. Environmental Protection Agency, Region X, Seattle, WA. Roy F. Weston, Inc., Seattle, WA. April.

Parametrix. 1994. Appendix B1—Southwest Harbor Cleanup and Redevelopment Project. Environmental Impact Statement. Aquatic Cleanup Feasibility Study. Prepared for: Port of Seattle, Washington State Department of Ecology and the U.S. Army Corps of Engineers. January.

BASEMAP EXPLANATION

Potential Fill Thickness in Meters

Extrapolated Fill Boundary

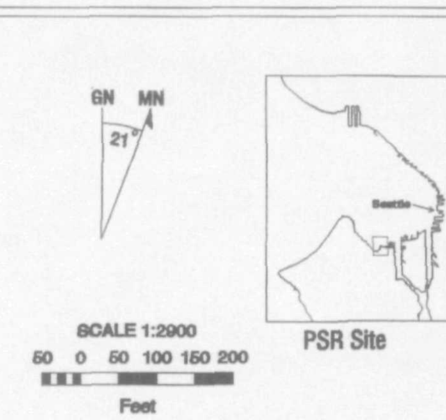
SYMBOL EXPLANATION

Below TOCN SQS or LAET

Above TOCN SQS or LAET

Above TOCN CSL or 2LAET

Asphalt Cap[4]



NOTES

1) Vertical datum is: Meters Mean Lower Low Water (MLLW).

2) Bathymetric data source: NOAA, 1970 and 1995.

3) Location of slurry wall, LNAPL trench, and monitoring wells approximate (RETEC, 1996 a&b).

4) Upland areas not capped with asphalt will be covered with clean fill and landscaping.

5) Exceedances based on individual or group totals for PAHs.

6) Fill contours from USGS sub-bottom profiling data (1996).

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APPROVED BY: ____________

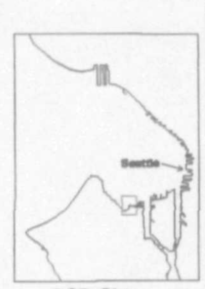
PSR Marine Sediments Unit
Surface Sediment PAH Exceedance[5] Areas and Potential Fill Contours[6]

Figure
1

BASEMAP EXPLANATION

Dredging Area

GN MN
21°



SCALE 1:2900
50 0 50 100 150 200
Feet

PSR Site

NOTES

1) See Figure 1 for site features notes.

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JOB NUMBER: 98-0221
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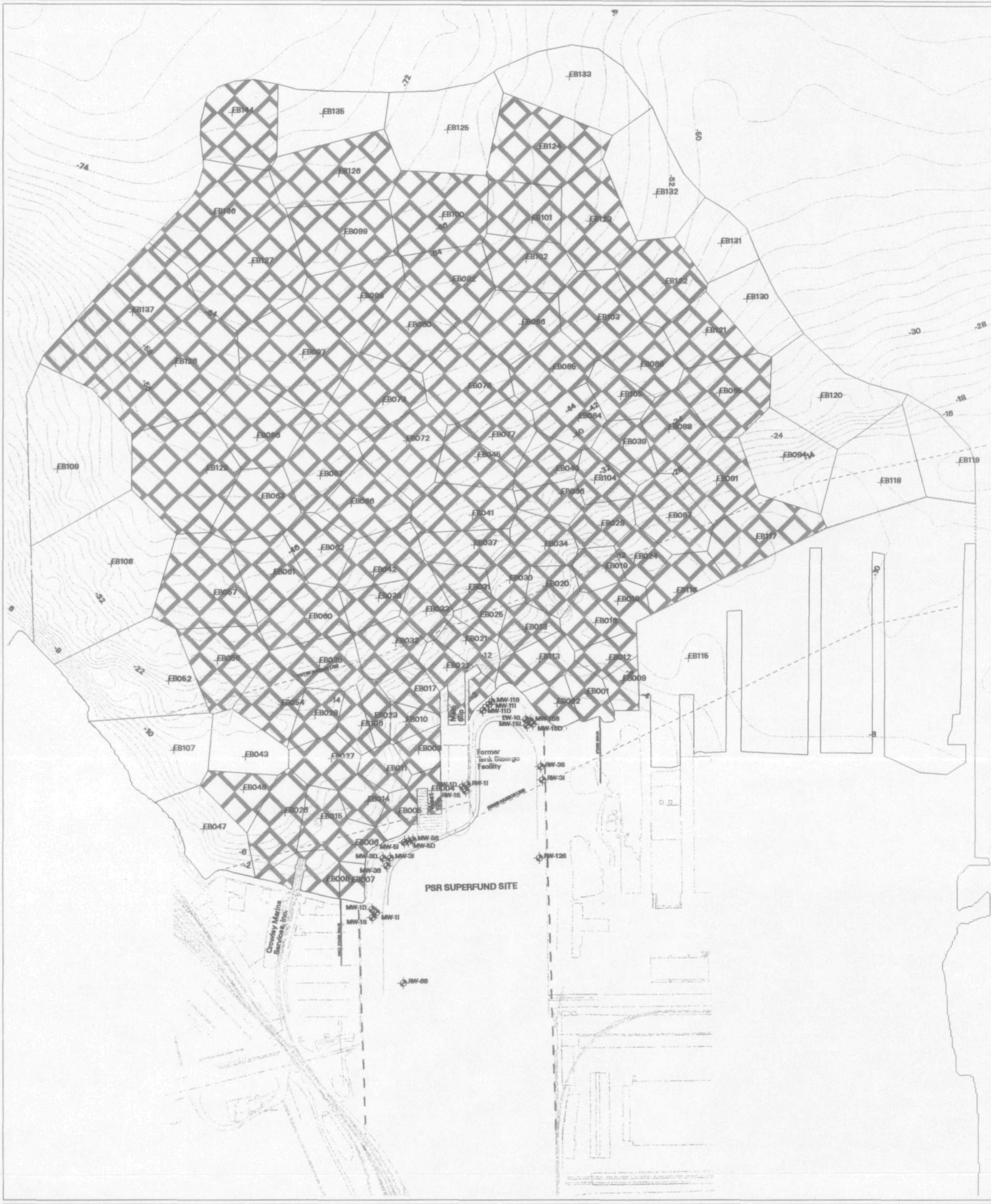
PSR Marine Sediments Unit
Alternative 2 – Dredge to CSLs

Figure
2



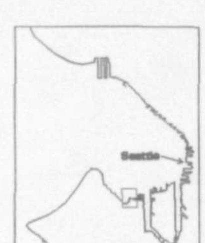
BASEMAP EXPLANATION

Dredging Area

Capping Area

GN MN

21°



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Feet

PSR Site

NOTES

1) See Figure 1 for site features notes.

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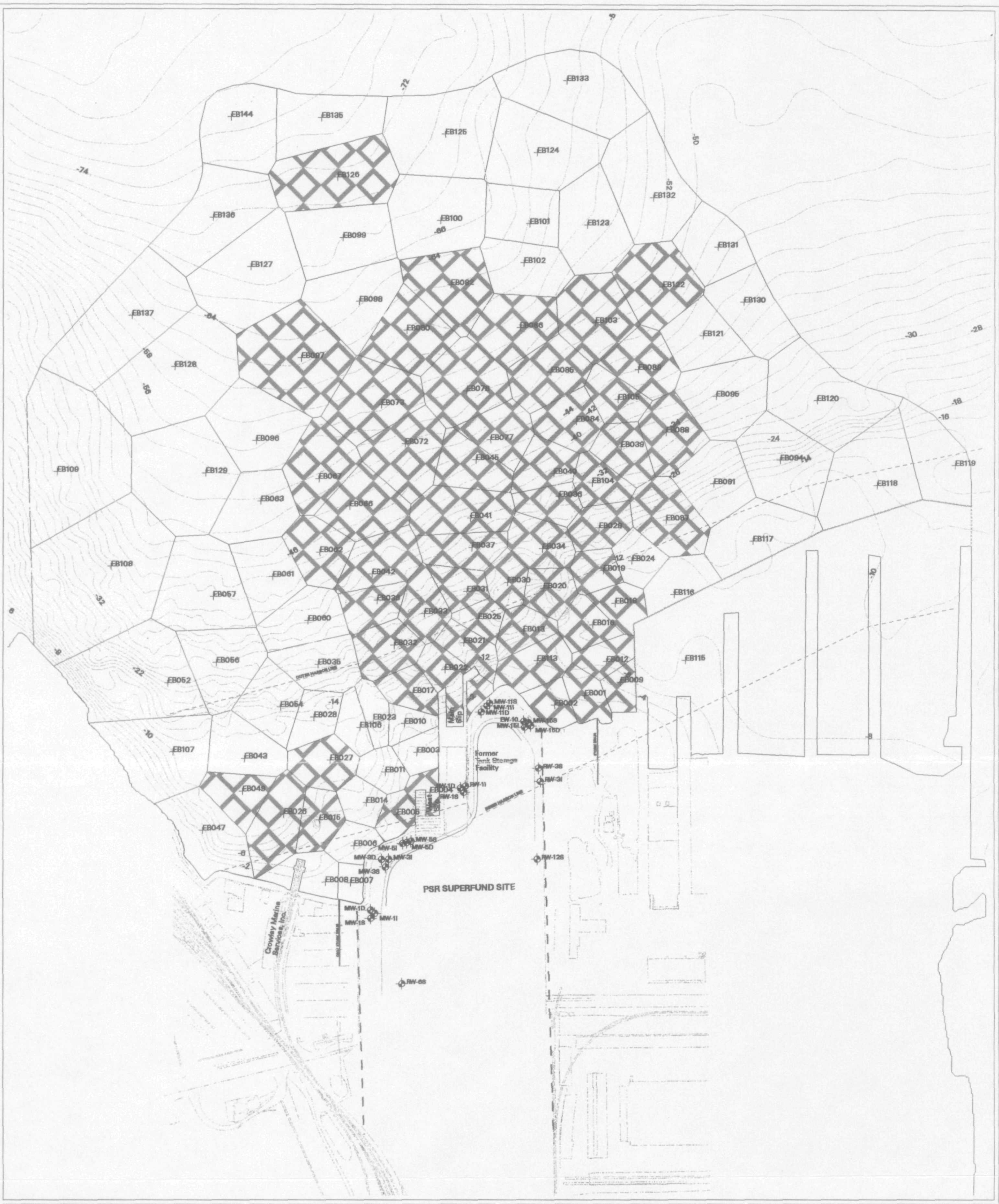
PSR Marine Sediments Unit
Alternative 3a – Capping to SQS

Figure

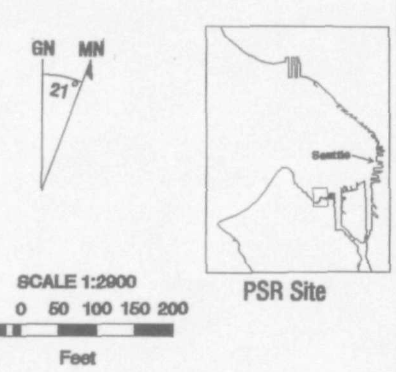
3



BASEMAP EXPLANATION

Dredging Area

Capping Area



SCALE 1:2900

50 0 50 100 150 200

Feet

NOTES

1) See Figure 1 for site features notes.

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PSR Marine Sediments Unit Alternative 3b – Capping to CSLs

Figure

4

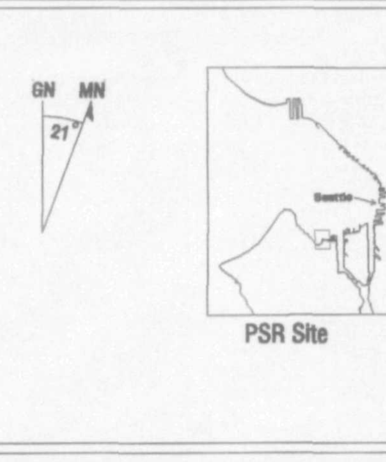
BASEMAP EXPLANATION

Dredging Area

Capping Area

Potential Fill Thickness in Meters

Extrapolated Fill Boundary



NOTES

1) See Figure 1 for site features notes.

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PSR Marine Sediments Unit
Alternative 4a – Potential Fill Removal to SQS Depth and Capping

Figure
5

BASEMAP EXPLANATION

Dredging Area

Capping Area

Potential Fill Thickness in Meters

Extrapolated Fill Boundary

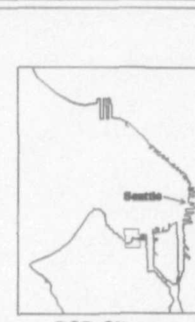
GN MN

21°

SCALE 1:2900

50 0 50 100 150 200

Feet



PSR Site

NOTES

1) See Figure 1 for site features notes.

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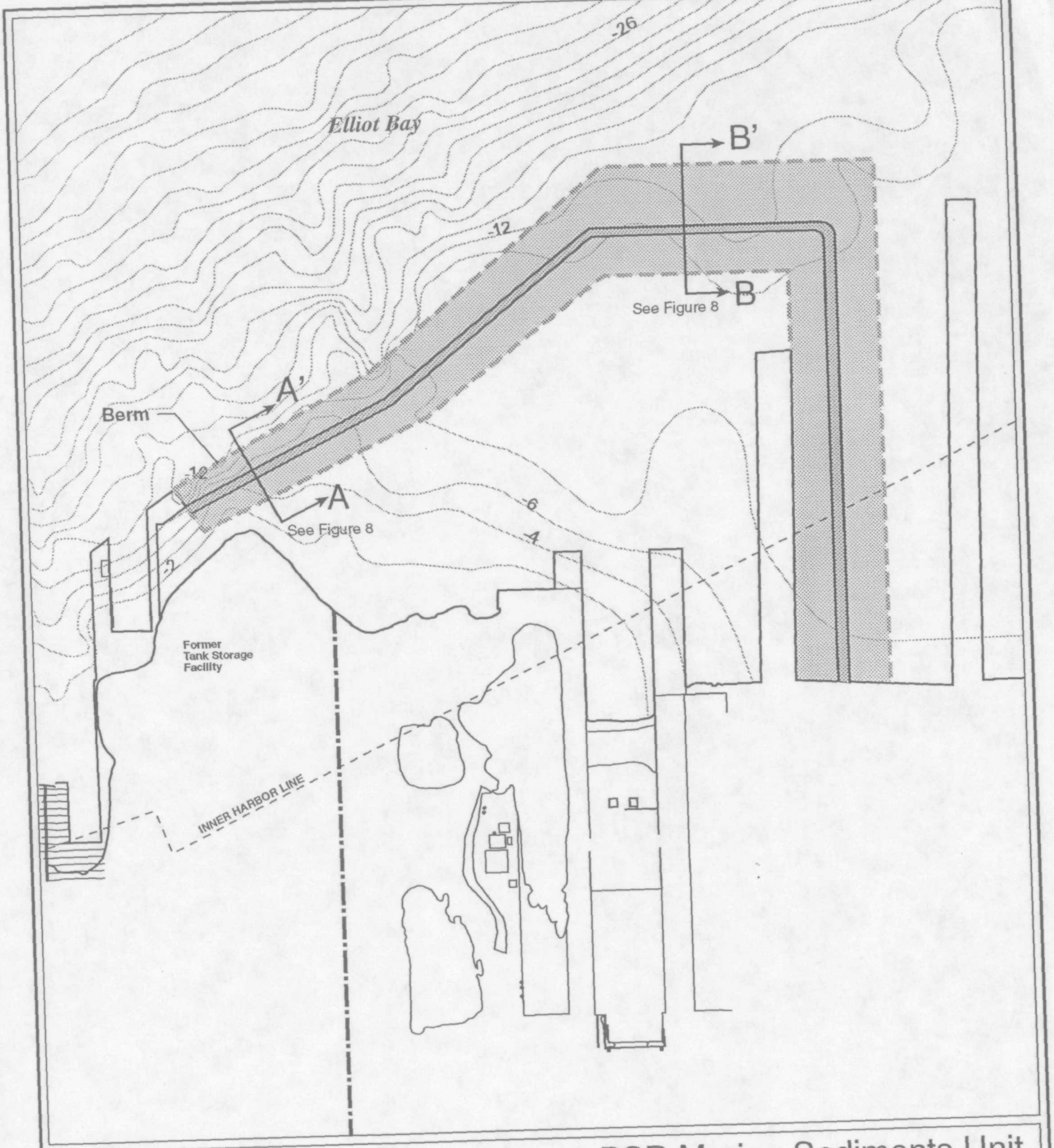
PSR Marine Sediments Unit Alternative 4b – Potential Fill Removal to CSL Depth and Capping

Figure

6



PSR Marine Sediments Unit Nearshore Disposal Configuration A 425,000 Cubic Yard Capacity

FIGURE
7

WESTON
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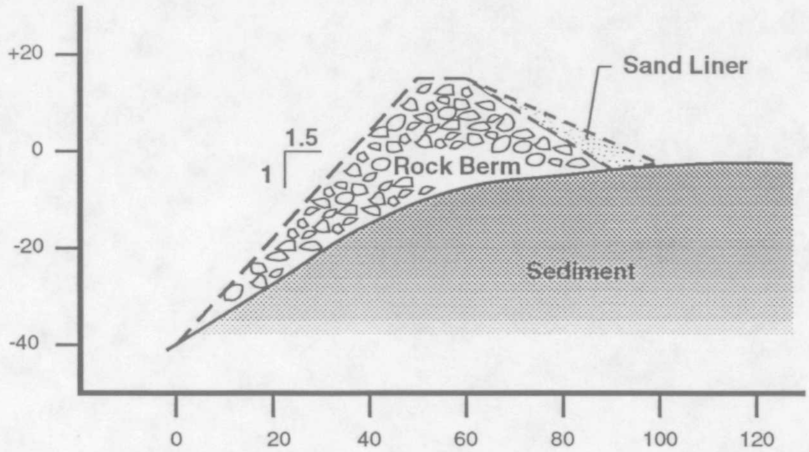
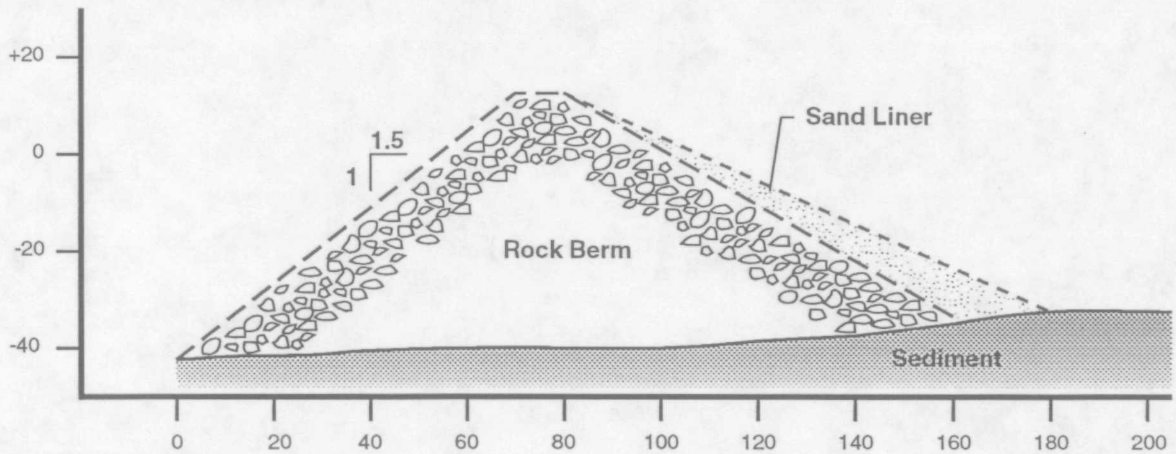
98-0221 Fig7.fh8



Section A'-A



Section B'-B

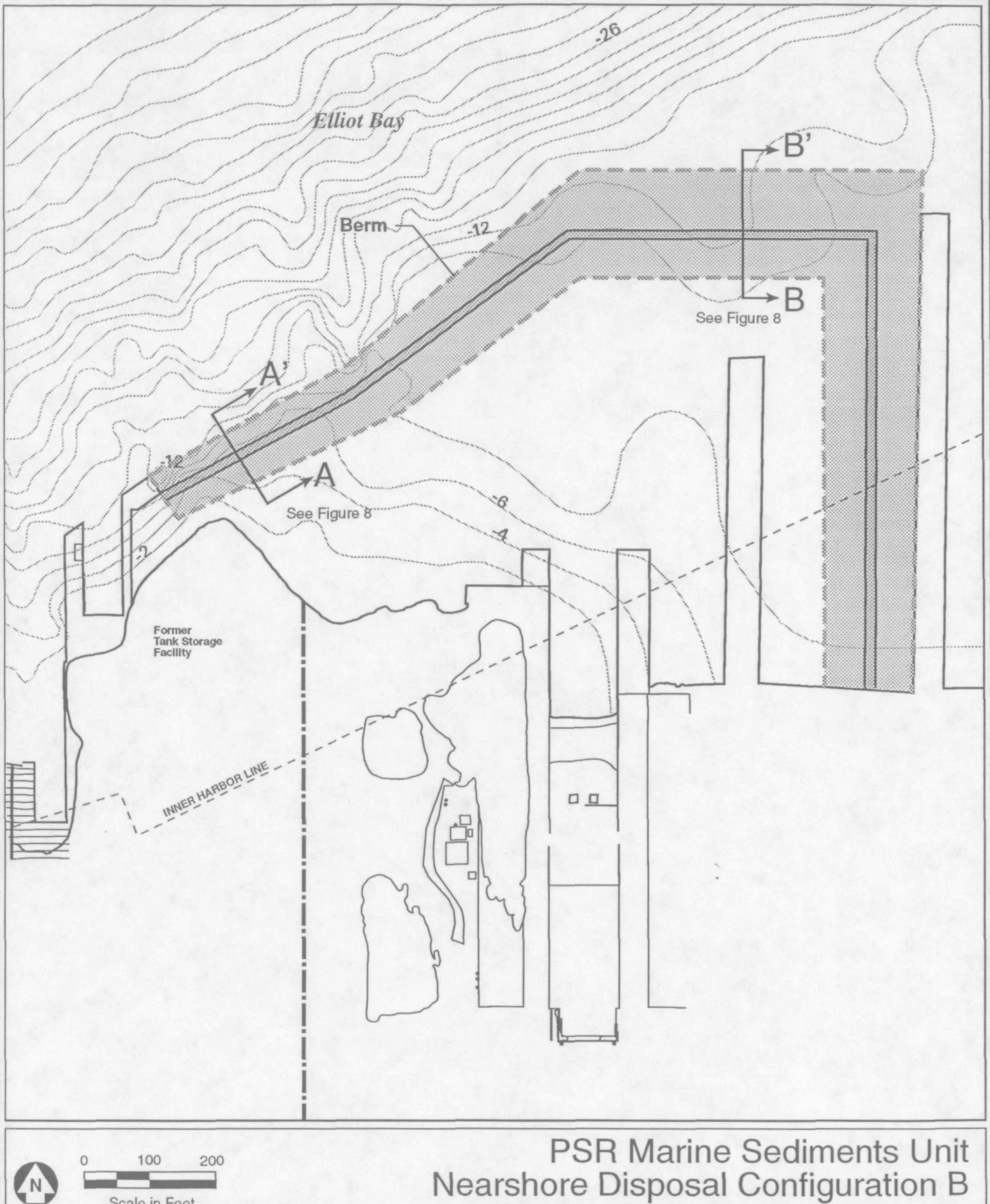
PSR Marine Sediments Unit
Berm Cross-Sections

FIGURE

8

WESTON MANAGERS DESIGNERS/CONSULTANTS

98-0221 Fig8.fh8



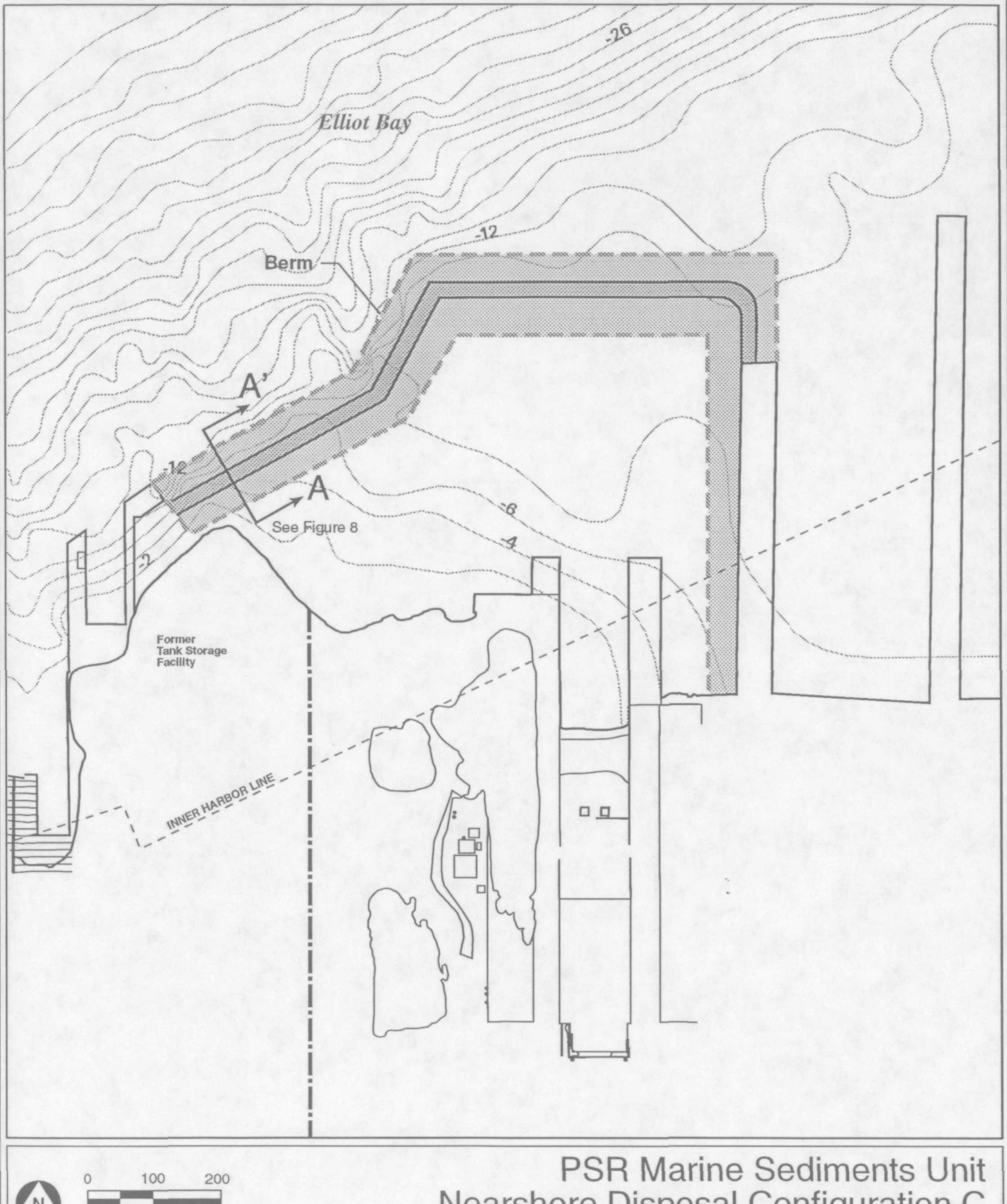
0 100 200
Scale in Feet

PSR Marine Sediments Unit
Nearshore Disposal Configuration B
450,000 Cubic Yard Capacity

WESTON MANAGERS DESIGNERS/CONSULTANTS

FIGURE
9

98-0221 Fig9.fh8



PSR Marine Sediments Unit
Nearshore Disposal Configuration C
326,000 Cubic Yard Capacity

WESTON
MANAGERS DESIGNERS/CONSULTANTS

FIGURE
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98-0221 Fig10.fh8